Z E S Z Y T Y N A U K O W E P O L I T E C H N I K I P O Z N A Ń S K I E J
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USE OF A CIRCULAR ECONOMY IN ENTREPRENEURIAL BUSINESS

The objective of this paper is to evaluate the impact of a circular economy on entrepreneurial business models and improving resource productivity in industrial business. A literature review and data analysis covers the issues concerning how circular analysis affects business effectiveness and state economy. Moreover, the article analyzes how to measure the effects of circular economy implementation on business and the economy. This article discovers the benefits of circular economy implementation for business and the economy and how it affects waste management. It is necessary to analyze a circular economy as a new economic model to improve waste recycling, becoming less dependent on primary energy and materials inputs, and ultimately being able to regenerate our natural capital. The article studies possible models of some practical aspects of circular economy implementation in entrepreneurial business models. The originality of this work lies in studying waste recycling and as a resource for manufacturing possibilities.

Keywords: circular economy, waste recycling, waste management, entrepreneurship

1. INTRODUCTION

The relationship between industry and environment is crucial for industrial business. Recent decades' environmental impact has incrementally increased pressure on manufacturing processes, and the lack of resources is one of the biggest challenges that confronts today's and tomorrow's industrial business.

The industrial revolution, mass production of goods was enabled by new manufacturing methods resulting in products with high quality and low costs. Due to new manufacturing technologies and consumer societies' emissions into the environment, solid waste generation and growing landfills have become increasingly

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severe. Due to the growing world population and especially strong middle-class growth, the demand for resources and consumption is rising rapidly. It has become important after the population migration to the cities led to the amount of waste generated by citizens to grow dramatically and become the source of infection, diseases and vermin.

According to the World Bank's Urban Development and Local Government Unit, it has escalated from 2.9 billion urban residents who generated about 0.64 kg of municipal solid waste (MSW) per person per day (0.68 billion tonnes per year) to today, where the amount has increased to about 3 billion residents generating 1.2 kg per person per day (1.3 billion tonnes per year). It is expected to increase to approximately 2.2 billion tonnes per year by 2025 [26, p. 8].

MSW generation rates are influenced by economic development, the degree of industrialization, public habits and local climate. The higher the economic development and urbanization, the greater the amount of solid waste produced.

Since natural resources are limited, the requirements of exponential economic and population growth cannot be met [15, p. 5]. The industrial business confronts the pressure of environmental regulations, natural resources limitations and increasing competition for access to scarce or critical resources. Given the underlying limitations of a linear economy, i.e. take-make-use-dispose, the concept of a circular economy is considered as a solution for economic growth [7].

The idea of a "Circular economy" is rapidly becoming one of the main ideas of waste and resources management and a mainstream concept, at least at the rhetoric level. Recent years' global publications draw our attention to waste recycling and resource recovery from the waste problem. The circular economy concept can be implemented in any kind of business type to reduce manufacturing costs and resource amounts. In recent global ecological reports, proper waste management is considered a global problem. A circular economy requires businesses to transform from the traditional model to one that is entrepreneurial in order to implement circular principles in daily activities easier. Because of the entrepreneurial manner and less resistance from interested parties, the idea of a circular economy can be implemented with more effectiveness.

In recent years, the European Union (EU) has sought to encourage a more sustainable approach to the management of resources. European Commission adopted an ambitious circular economy package to stimulate Europe's transition towards a circular economy which will boost global competitiveness, foster sustainable economic growth and generate new jobs [2, p. 2].

The object of the paper is to evaluate the impact of a circular economy on entrepreneurial business models and improving resource productivity. The main approach employed in the project is meta-analysis. The meta-analysis utilized both academic and grey literature (non-academic, but reputable sources) and data analysis to examine how a circular economy will affect business effectiveness and state

economy. First, this paper will outline the basic definition of a circular economy and the possibilities of its rational implementation. Then, the research based on statistical data analysis will be presented. At last, it will discuss the methodology of a circular economy developed by the Ellen MacArthur Foundation. The Ellen MacArthur Foundation proposed a company-level methodology that helps to measure the effectiveness of the transition from "linear" to "circular" models. The Material Circularity Indicator (MCI) assesses how well a company performs in the context of a circular economy, thereby allowing companies to estimate how advanced they are on their journey from linear to circular.

2. LITERATURE REVIEW

2.1. Defining a "circular economy"

The concept of a "circular economy" was developed by environmental academics in the 1970s. It became more popular in the latest decades. In today's economy natural resources are mined and extracted, turned into products and discarded by using the linear economy principle. Waste collection and recycling can reduce the need for extraction of raw materials. In a circular economy, the resource loop would be closed and large volumes of resources are captured and reused [17, p. 3]. Still, waste recycling policy is not effective and about 50 per cent of waste still goes to landfills.

A circular economy includes production and consumption sectors in order to reduce amounts of waste generated, increasing the amount of collected and recycled waste at the same time. The idea of a "circular economy" is rapidly becoming a mainstream concept at the rhetorical level. Many other prevailing or emerging ideas relate to the circular economy: resource recovery, resource efficiency, resource effectiveness, sustainable consumption and production, system of provision, industrial symbiosis, urban metabolism, zero waste, eco-design, materials criticality, design for recycling, cascade models, remanufacturing, waste prevention and minimization and sustainability. However, the circular economy can be defined as the returning of used resources, that would otherwise become waste, back into the economy [24, p. 390].

Since the European Commission published its communication "Towards a Circular Economy: A Zero Waste Programme for Europe" in 2014, scientists started to analyze the circular economy implementation possibilities. States aim to establish "producer responsibility" to stimulate the design of goods that can be more easily repaired, reused, disassembled or recycled [8, p. 6].

The European Union seeks for the circular economy to boost global competitiveness, foster sustainable economic growth and generate new jobs. It is necessary to reform the economy in order to encourage more efficient use of natural resources and reduce environmental pollution. European Commission developed and proposed a circular economy model (Fig. 1), which helps to keep product added value as long as possible, avoiding waste formation.

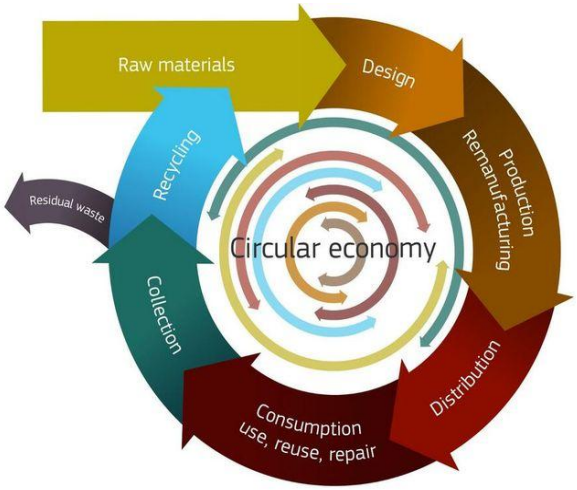

Fig. 1. Model of a circular economy [9]

The concept of a circular economy implies highly efficient use of resources and recycling, reduction, re-use, low consumption, low emission, high-efficience features, in line with the concept of sustainable development of economic growth. Finally it helps to achieve optimal production, optimal consumption and minimum waste indicators [28, p. 439].

The circular economy requires changes in all industrial business stages from design to application. It also leads to the new business model, where waste is considered as a resource.

2.2. Implementation of a circular economy in entrepreneurial business

Neo-classical theory has identified the economic growth driving factors: physical capital, technological knowledge and labour [19, p. 5]. Social factors are also important in generating economic growth. Social factors focus on social capital, which consists of connections among individuals – entrepreneurship [23, p. 35].

Understanding the role of entrepreneurship requires the decomposition of the concepts. The entrepreneurship definition is too complex to be explained through a single set of factors. The term "entrepreneur" was introduced by R. Cantillon, the central component of his definition is that the entrepreneur gravitates towards assuming risk [22, p. 438].

Other authors [18; 6] see an entrepreneur as an innovator or coordinator of production. Entrepreneurship occurs under five conditions of newness: new goods, new production methods, new markets, new sources of materials and new organizations.

Today's businesses confront new challenges that have a significant impact on their environment, shape their behaviour and encourage implementing new work and business models. The entrepreneurship firms have to continuously innovate to remain competitive [1, p. 116]. The definition of entrepreneurship is a multidimensional concept, involving aspects of uncertainty-bearing, innovation, opportunity-seeking, management and enterprising individuals [10, p. 14]. A circular economy is the main competitiveness factor for future business organizations. The importance of waste consumption and recycling leads to new technologies and innovations in all industrial sectors and business operations. Entrepreneurs are orientated to innovations and new product design where the circular economy can be successfully implemented.

The circular economy concept is based on innovation implementation in industrial business. It benefits all business, especially small and medium enterprises (SMEs). Waste can be used six ways and improve incentives: regenerate (repair), share (re-use), optimise (to find efficiency gains), loop (recycle), virtualise (use software on generic machines rather than manufacturing specialised machines) and exchange (replace traditional materials with recoverable, renewable or bio-based ones). The circular economy is already profitable for companies that decide to employ it [3].

Although using waste as a renewable resource for energy production is taking the first steps, technological development and innovations are leading to its rapid implementation. Part of business transformation to the entrepreneurship model is discovering cheap waste disposal techniques to ensure environmental principles implementation in daily business activities. The private sector's involvement in the circular economy implementation means that the key success factors of competition, transparency and accountability are present. The private sector improves efficiency and lowers costs by introducing commercial principles, financial and managerial autonomy, a hard budget constraint and clear accountability to both customers and providers of capital. The private sector can provide needed investment funds, new ideas, technologies and skills [26].

The circular economy covers all industrial sectors and business types. It is based on a few industrial system principles (Fig. 2).

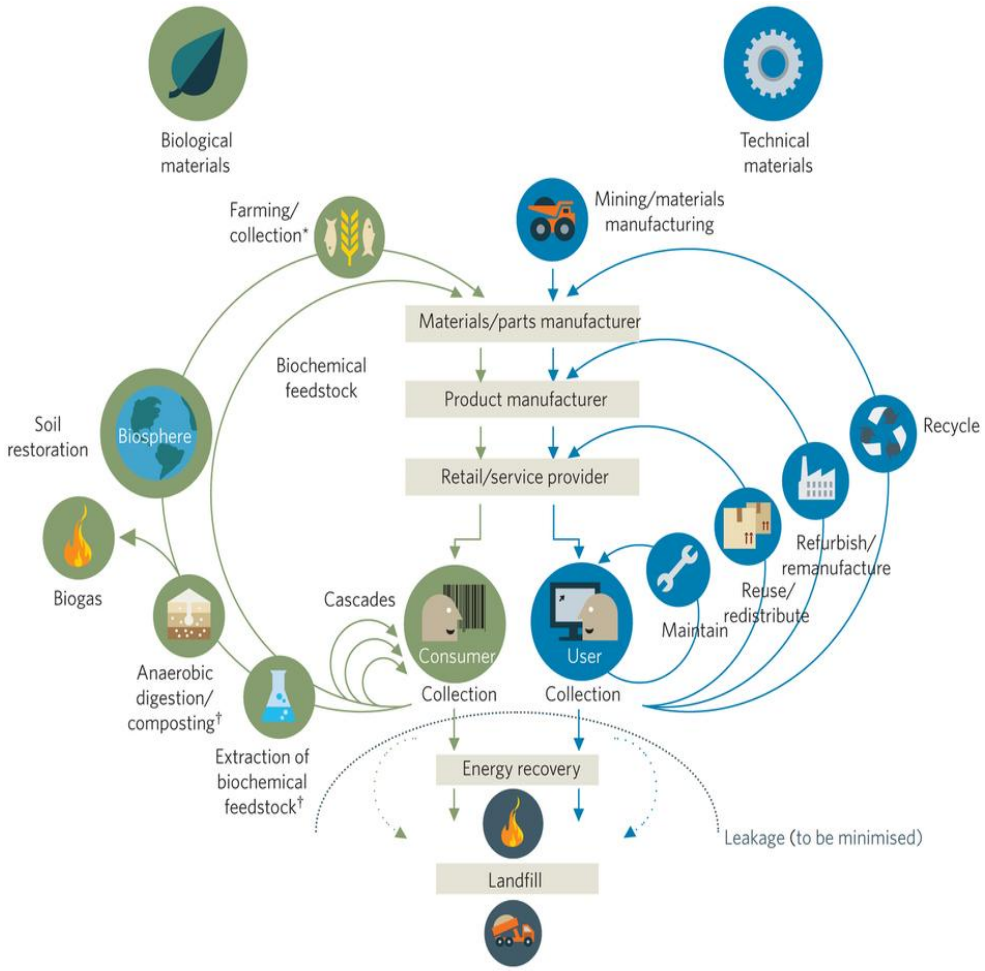

Fig. 2. Model of the circular economy and industrial system [12]

First, the circular economy aims to design out waste. In this model, waste does not exist: products are designed and optimised for a cycle of disassembly and reuse. Second, circularity introduces a strict differentiation between consumable and durable components of products. Third, the energy required to fuel this cycle should be renewable by nature. It helps to decrease resource dependence and increase systems resilience [12].

Circular economy implementation in the business cycles requires entrepreneurship thinking. Entrepreneurship is important in the circular economy mechanism through which inefficiencies in economies are identified and mitigated. The entrepreneur has two major roles for economic growth and development: "new entry" and "newness" in general. Firstly, the entrepreneur is the founder of a new busi-

ness. Secondly, the entrepreneur is an innovator. He transforms inventions and ideas into economically viable entities [25, p. 33]. Thus, newness through circular economy and innovations are one of the most relevant factors linking entrepreneurship to economic growth in today's reality.

3. MATERIAL AND METHODS

A circular economy is a global economic model that aims to decouple economic growth and development from the consumption of finite resources. International organizations analyse circular economy possibilities and its payback. A circular economy model not only allows to capture additional value from products and materials, but also to mitigate risks from material price volatility and material supply.

Waste consumption and recycling statistical data analysis helps give a general overview of waste management problems and their opportunities.

International organizations: World Bank, European Union, Ellen MacArthur Foundation analyse circular economy implementation possibilities and the economic benefit for business and the world economy in general.

The Ellen MacArthur Foundation developed a circular economy methodology and implementation model [13, p. 7]. The model of circular economy differentiates between two types of cycles:

1. Biological cycles where non-toxic materials are restored into the biosphere while rebuilding natural capital, after being cascaded into different applications.
2. Technical cycles where products, components and materials are restored into the market at the highest possible quality through repair and maintenance, reuse, refurbishment, remanufacture and recycling.

These strategies are illustrated on the circular economy system diagram in our discussed Figure 2.

The development of the company Material Circularity Indicator (MCI) is based on the hypothesis that the material circularity of a company can be built up from the material circularity of the company's products. The assessment may cover any time period. It can be one year or even longer. MCI assessment can be taken for every single product placed on the market. The Material Circularity Indicator MCIc for the company is:

$$MCI_c = \frac{1}{N_c}\sum_{\alpha}(N_{D(\alpha)} \times MCI_{D(\alpha)} \tag{1}$$

where:

$$N_c = \sum_{\alpha} N_{D(\alpha)} \tag{2}$$

MCIc – Material Circularity Indicator of a company;
ND – Total normalising factor

This methodology takes a reference product approach where each reference product presents a range of similar products. This is helpful for companies deciding if is it effective to use recycled products in the manufacturing process.

4. RESULTS AND DISCUSSION

Fossil fuels can currently provide about 80 percent of the world's primary energy demand, but it will be exhausted in the near future. Therefore more and more attention must be paid to the renewable sources of energy. It is very important to know what is the potential of these sources to supply energy on a large scale [16, p. 31].

The research is divided into two parts. First is the circular economy's effect on waste collection, recycling and business while the second is the analysis of the circular economy's implementation in the evaluation model.

Wastes are considered as renewable energy sources but their possibilities are not fulfilled. Waste management integrates five basic stages: generation, reduction, collection, recycling and disposal. One of the objectives of waste management is to optimise these five stages to provide the most efficient and economic practices commensurate with the socio-technological and environmental constraints imposed [20, p. 3].

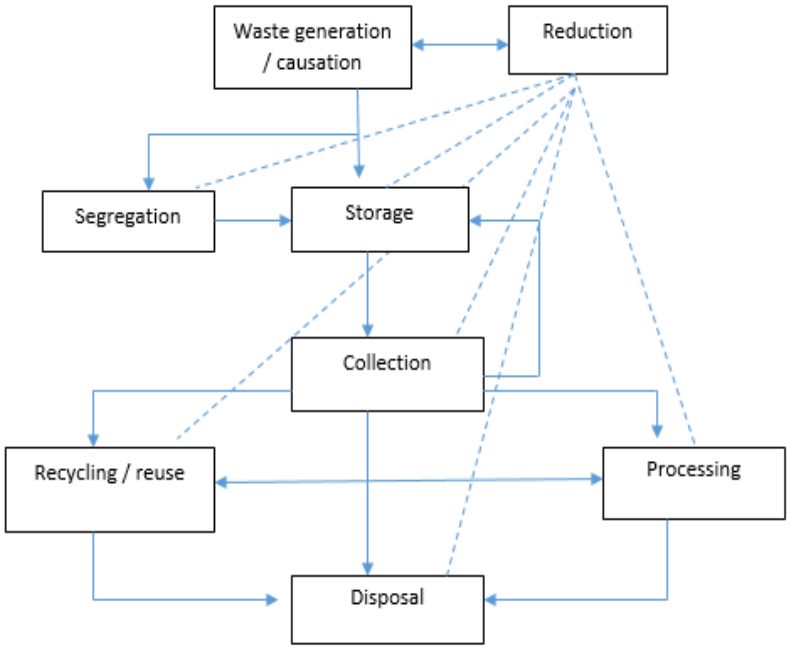

Fig. 3. Functional elements of Waste Management [20]

In 2012 the EU generated over 2 514 million tonnes of waste and this number is still growing (Table 1). The larger the economies the higher the rate of waste generated (e.g. Germany generates over 368 million tonnes of waste, France – 344 million tonnes of waste, United kingdom – 241 million tonnes of waste). The World Bank estimated that in the past the 2,9 billion population generated about 0,64 kilograms of household waste per person per day (0,68 billion tonnes per year). Today, the 3 billion population generates 1,2 kilograms of household waste per person per day (1,3 billion tonnes per year). In 2025 a 4,3 billion population will generate 1,42 kilograms of household waste per person per day (2,2 billion tonnes of waste) [11, p. 324].

Table 1. Waste generation by economic activities and households, 2012, thousand tonnes [4]

GEO/WASTE	Total Waste	Recyclable wastes	Equipment	Mixed ordinary wastes	Common sludges	Mineral and solidified wastes
European Union (28 countries)	2.514.220	242.390	16.000	282.010	21.510	1.784.370
Belgium	67.630	12.836	387.293	7.597	2.829	35.181
Bulgaria	161.252	1.925	120.976	3.599	62.562	154.212
Czech Republic	23.171	4.808	69.518	3.800	797	12.408
Denmark	16.332	3.261	163.118	4.282.022	171.928	7.270
Estonia	21.992	1.492	30	518	25	18.234
Ireland	13.421	1.360	264	3.968	408	4.538
Greece	72.328	2.000	193	5.547	109	63.811
Spain	118.561	13.352	1.094	29.110	1.427	62.097
France	344.731	33.735	2.228	38.097	1.470	252.705
Croatia	3.378	781	62	1.483	17	855
Italy	162.764	25.740	2.717	37.437	6.226	64.877
Cyprus	2.086	309	19	246	15	1.254
Latvia	2.309	311	20	1.044	77	676
Lithuania	5.678	903	70	1.286	52	2.731
Luxembourg	8.397	434	14	274	10	7.539
Hungary	16.310	2.936	98	3.504	277	8.142
Malta	1.452	63	15	266	10	1.067
Netherlands	123.612	8.489	505	9.501	636	87.398
Austria	34.047	5.581	155	4.374	471	20.965
Poland	163.377	12.630	220	18.056	586	123.443

Table 1 – continued

GEO/WASTE	Total Waste	Recyclable wastes	Equipment	Mixed ordinary wastes	Common sludges	Mineral and solidified wastes
Portugal	14.184	4.475	233	5.405	686	2.484
Romania	266.975	5.500	133	6.325	277	235.503
Slovenia	4.546	952	29	775	84	2.177
Slovakia	8.425	1.644	32	1.589	285	3.388
Finland	91.824	13.456	224	2.880	391	72.980
Sweden	156.306	5.587	581	5.078	602	141.173
United Kingdom	241.100	40.530	3.819	41.613	2.154	137.439

In 2012, the average European used 16 tonnes of materials. Of those discarded materials 60 percent ended up either in landfills or incinerated and only 40 percent were recycled or reuseable materials. In value terms, Europe lost 95 percent of the material and energy value. Even the recycling of steel, PET and paper loses 30-75 percent of the material value in the first use cycle. On average, Europe uses materials only once [13, p. 12].

Linear consumption is reaching its limits. A circular economy is a trillion-dollar opportunity with huge potential for innovation, job creation and economic growth. Today's companies harvest and extract materials for manufacturing. About 65 billion tonnes of raw materials entered the economic system in 2010, and this figure is expected to grow to around 82 billion tonnes in 2020. A linear economy increases resource prices and supply distributions [27, p. 13].

The use of the circular economy principles can bring a three times decrease in the demand for primary materials in the widget market (Fig. 4).

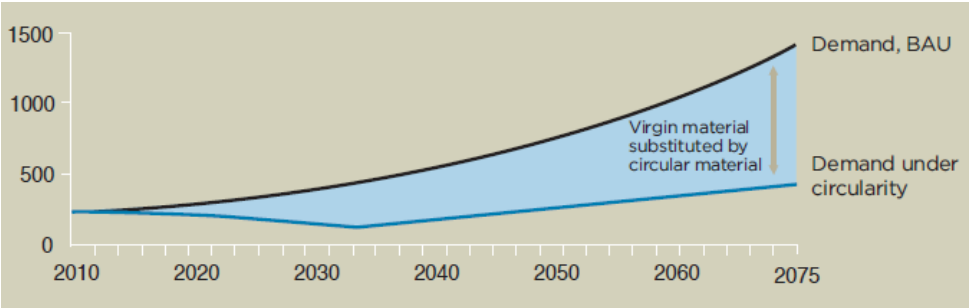

Fig. 4. Effect of circular economy on primary material demand in widget market [27]

A circular economy can reduce the demand for primary materials about 17-24 percent and at the EU level it will save US$ 520 – 360 billion [27, p. 18].

European sector analyses showed that use cycles are short. The average manufactured asset lasts only nine years. In total, today production and resources cost' Europe 7.2 trillion euro every year for the three analyzed sectors: mobility, food and built environment. Resource costs are about 1.8 trillion euro. In general, this means that circular economy implementation can increase annual benefits up to 25 percent (1.8 trillion euro) in Europe by 2030 (Fig. 5).

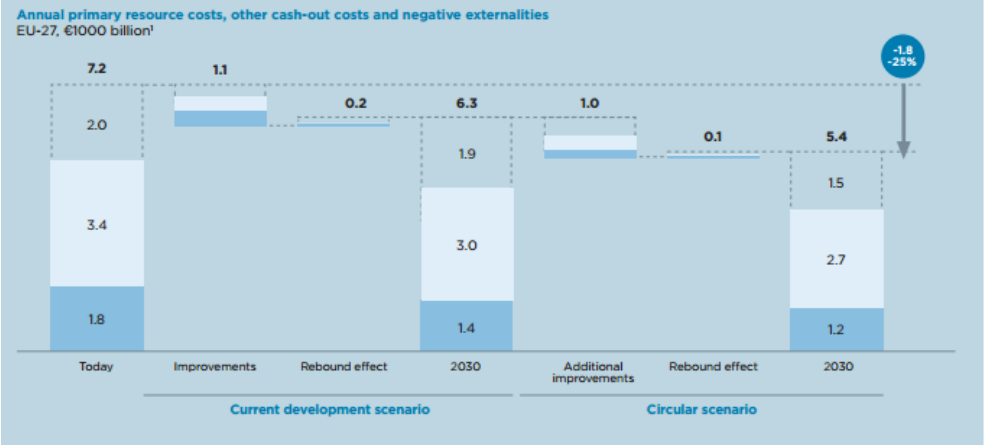

Fig. 5. The circular economy opportunity – 2030 scenarios [13]

To understand how to measure the circular economy in business the Ellen MacArthur Foundation had created Material Circularity Indicator (MCI). For example, a company produces 2 products ranges: Product 1 and Product 2. Product 1 is made with highly recycled content. Product 2 is not recycled (Table 2).

Table 2. Summary of input data for products supplier (own study)

No.	Name of product range	Total product mass of product range	Revenue, euro	MCI of ref. product
1	Product 1	9 600	60	0,68
2	Product 2	3 560	42	0,22

Using the Aggregator Tool, the results are such that using mass as a normalising factor, the MCI of the company would be 0,56. Using revenue the MCI would be 0,49.

In this example, it is clear that because of its higher density the MCI for Product 1 dominates the combined result when mass is used as the normalising factor (Fig. 6). On the other hand, using revenue gives a more balanced view of the company and should be chosen as the preferred option in this case (Fig. 7). If MCI would be closer to Product 1, it would mean that the company should produce more of Product 1 and have to discontinue Product 2.

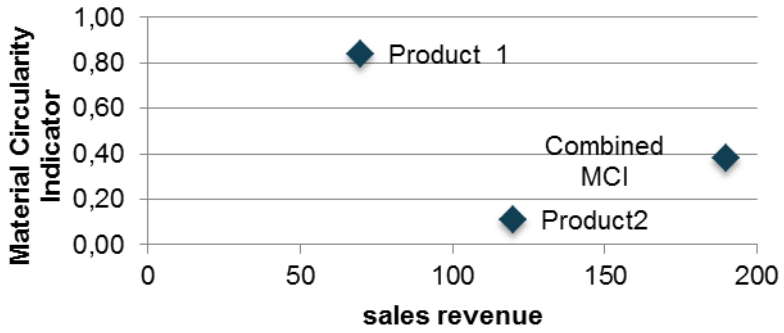

Fig. 6. Combining the MCIs using mass as the normalising factor (own study)

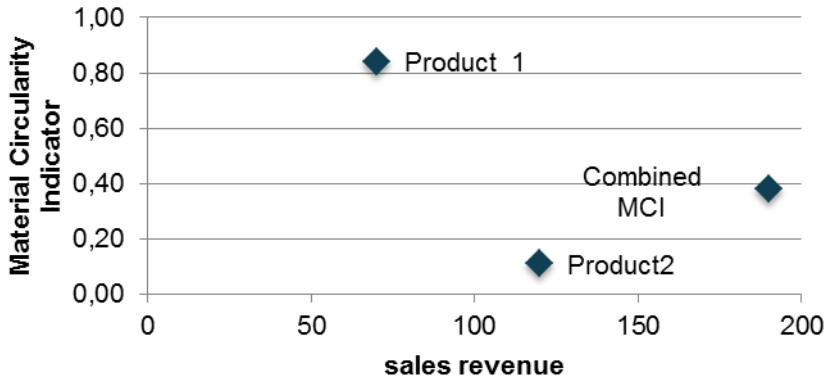

Fig. 7. Combining the MCIs using sales revenue as the normalising factor (own study)

This method is useful for the evaluation of circular economy principles implementation in the company. It helps to measure the effectiveness and financial payback of production from recycled waste.

5. CONCLUSIONS

A circular economy helps to improve industrial business productivity and ensure continual economic growth. Because of the waste crisis, low productivity and rapid exploitation of natural resources it is important to implement an integrated waste management policy in the circular economy's context. A circular economy includes manufacturing and consumer sectors, systematically reduces emission of waste and encourages waste recycling to raw materials, as well as energy production.

Entrepreneurial businesses are seen as innovators of new goods, new production methods, new markets, new sources of materials, etc. From this point of view entrepreneurs are primaries that can see the benefits and possibilities of a circular economy. The importance of waste consumption and recycling leads to new technologies, innovations in all industrial sectors and new business models.

Waste used as a raw material in manufacturing and energy production can resolve environmental issues and reduce the increasing amount of waste in the world. The growing amount of waste in the world and Europe is a ticking bomb which requires a rapid solution and effective implementation. While linear consumption is reaching its limits, a circular economy can be seen as a solution. Today, use cycles are short. To satisfy demand, a business has to produce more and more product. This leads to a rapid increase in waste. A circular economy can reduce the demand for primary resources by about 17-24 percent and this will save more than 1.8 trillion euro in the Europe market.

The Ellen MacArthur Foundation created the Material Circularity Indicator (MCI) which can measure how well a product performs in the context of a circular economy and estimate how advanced it is in the context of circular economy implementation.

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ZASTOSOWANIE GOSPODARKI OBIEGOWEJ W SYSTEMIE PRZEDSIĘBIORCZOŚCI

Streszczenie

Celem niniejszej pracy jest ocena wpływu gospodarki kołowej na modele biznesowe przedsiębiorczości i poprawę produktywności zasobów w branży przemysłowej. Przegląd literatury i analiza danych obejmuje zagadnienia dotyczące sposobu analizy obiegowej i wpływu na efektywność biznesu i gospodarki państwa. Ponadto w artykule przeanalizowano sposoby mierzenia efektów wdrożeniowych gospodarki obiegowej w biznesie i gospodarce. W artykule ukazano korzyści wdrożenia gospodarki obiegowej w biznesie i gospodarce oraz jak wpływa na gospodarowanie odpadami. Konieczna jest analiza gospodarki obiegowej jako nowego modelu gospodarczego w celu poprawy recyklingu odpadów, coraz mniej zależnego od nakładów energii i surowców pierwotnych, a ostatecznie umożliwiającego zregenerowanie naszych surowców naturalnych. Artykuł dotyczy analizy dostępnych modeli niektórych praktycznych aspektów wdrażania gospodarki obiegowej w modelach biznesowych przedsiębiorczości. Oryginalność pracy wiąże się z badaniami recyklingu odpadów jako źródła możliwości produkcyjnych.

Słowa kluczowe: gospodarka obiegowa, recykling odpadów, gospodarowanie odpadami, przedsiębiorczość